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Fundamentals

The thin-bed adhesives commonly in use today are required to undergo numerous tests specified by the following control documents:

- European standards governing tile adhesives
- German Construction Chemicals Manufacturers' Association
- German Tiling Association (in Federation of the German Construction Industry)
- German Ceramic Tile Industry Association
- German Adhesives Industry Association

Definition and specification

Thin-bed adhesives used for laying ceramic tiles are required to meet various performance criteria, which are precisely defined in European standard **DIN EN 12004** (and ISO 13007 Part 1).

The following designations are used for the different binder types:

C ➔ **cementitious adhesives**

D ➔ **dispersion adhesives**

R ➔ **reaction resin adhesives**

Cementitious adhesives (C) are rated and classed in terms of tensile adhesion strength and deformability to DIN EN 12004. Tensile adhesion strength is tested for various storage conditions. Cementitious adhesives are required to achieve values $\geq 0.5 \text{ N/mm}^2$ or $\geq 1 \text{ N/mm}^2$ in all cases to allow them to obtain a C1 or C2 rating respectively.

Storage conditions:

	Class C1	Class C2
Tensile adhesion strength after dry storage	$\geq 0.5 \text{ N/mm}^2$	$\geq 1 \text{ N/mm}^2$
Tensile adhesion strength after water storage	$\geq 0.5 \text{ N/mm}^2$	$\geq 1 \text{ N/mm}^2$
Tensile adhesion strength after heat storage	$\geq 0.5 \text{ N/mm}^2$	$\geq 1 \text{ N/mm}^2$
Tensile adhesion strength after freeze-thaw cycling	$\geq 0.5 \text{ N/mm}^2$	$\geq 1 \text{ N/mm}^2$

Both C1 and C2 require a tensile adhesion strength $\geq 0.5 \text{ N/mm}^2$ after an open time of 10 minutes for rapid-set adhesives and an open time of 20 minutes for normal-setting adhesives. For rapid-set adhesives, a tensile adhesion strength $\geq 0.5 \text{ N/mm}^2$ is required after six hours. Cementitious adhesives with a Class C2 rating meet considerably higher performance standards.

C = cementitious adhesive



Due to their material composition, dispersion and reaction resin adhesives are tested and classed according to shear strength.

Dispersion adhesives exhibiting a minimum shear strength of 1 N/mm^2 after dry and heat storage receive a D1 rating. The D2 rating additionally requires a minimum shear strength of 0.5 N/mm^2 after water storage and a minimum value of 1 N/mm^2 at elevated temperatures. Both D1 and D2 require a tensile adhesion strength $\geq 0.5 \text{ N/mm}^2$ after an open time of 20 minutes.

D = dispersion adhesives



Reaction resin adhesives are given an R1 rating where they achieve a minimum shear strength of 2 N/mm^2 after dry and water storage. The R2 rating additionally requires a minimum shear strength of 2 N/mm^2 after temperature cycles. Both R1 and R2 require a tensile adhesion strength $\geq 0.5 \text{ N/mm}^2$ after an open time of 20 minutes.

R = reaction resin adhesives



Application properties:

Extra letters, e.g. T, E and F, may be added to the rating code to indicate supplementary application properties.

T = thixotropic/high sag resistance

E = extended open time (only applicable to cementitious and Class D2 dispersion adhesives)

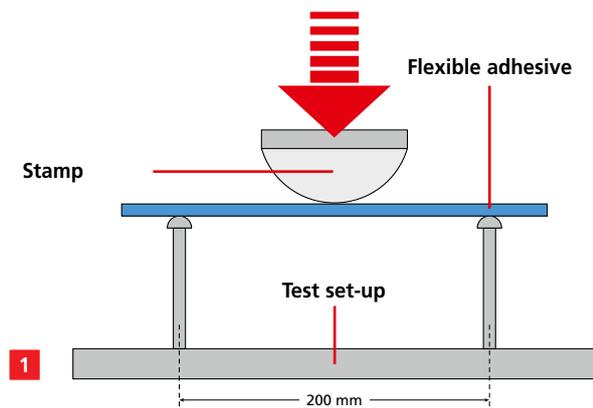
F = fast-setting (only applicable to cementitious adhesives)



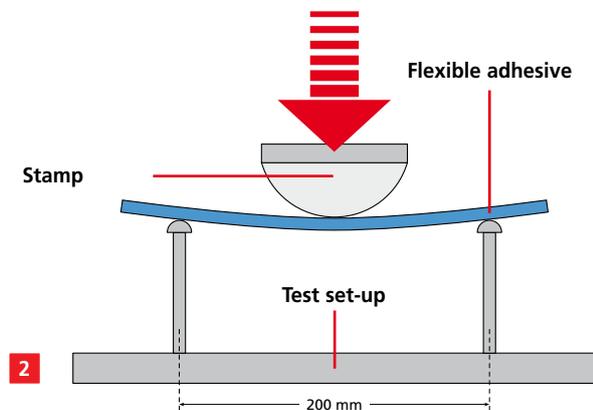
Fundamentals

Deformability

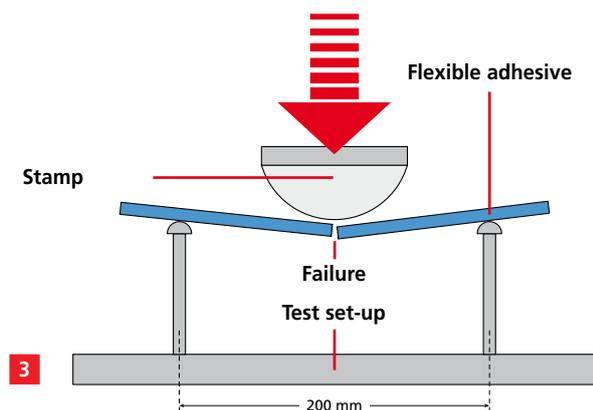
To characterize the flexibility of cementitious adhesives, these are additionally rated in terms of deformability to **DIN EN 12004**. To determine this rating, a predefined specimen (strip of material) undergoes a deflection test.



Test set-up to determine flexibility of thin-bed adhesives based on deflection.



Determination of maximum deflection.



Adhesive strip tested to failure.



Set-up for S1/S2 rating test.

A minimum deformability of 2.5 mm is required for an S1 rating. Class S2 is reserved for highly deformable flexible adhesives which achieve a minimum deflection of 5 mm.



≥ 2.5 mm



≥ 5 mm

The now outdated German Flexmortar guidelines, which were not effective at European level, previously specified national requirements for flexible, one-component adhesives.

Any adhesive complying with the minimum requirements for a Class C2 rating to DIN EN 12004 in conjunction with a minimum deformability of 2.5 mm was automatically awarded the lozenge-shaped Flexmortar quality label.

Indeed, cementitious tile adhesives that meet the much stiffer test criteria to DIN EN 12004 (with C2/S1 rating) actually exceed the requirements of the German Flexmortar guidelines.



Additional CE marking

The CE mark is affixed by manufacturers to confirm the conformity of their products with the relevant European standards. CE marking has been mandatory for thin-bed tile adhesives since 1.04.2004 and serves as a kind of "product passport" to permit the free movement of goods within Europe. The minimum requirement is a Class C1 rating to DIN EN 12004.

Ceramic tiles

Earthenware and stoneware products are a very popular choice among the many different finishing materials and feature prominently on many construction schemes. They are simple to install and have proved their worth as coverings over many years.

Their open-pored texture (see scanning electron microscope images) ensures good interlock between tile and bedding adhesive, resulting in a strong bond.

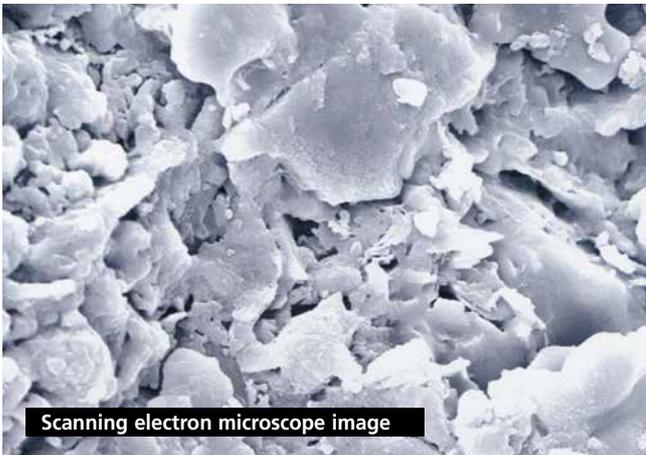
Standard approved thin-bed adhesives to DIN EN 12004 are adequate for tile laying.

Product recommendations

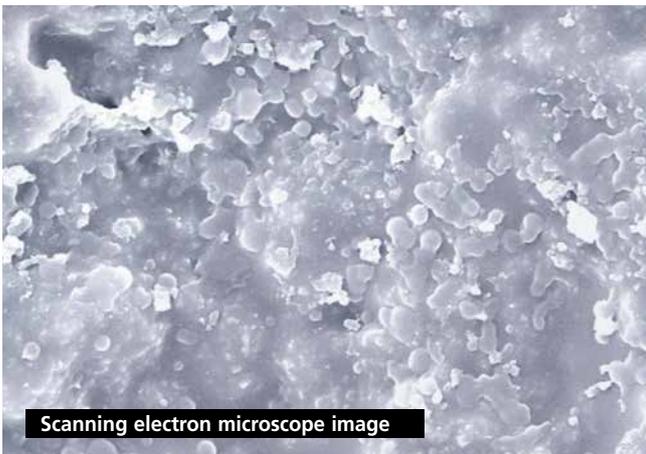
The installation of ceramic tiles on floor surfaces necessitates more or less void-free bedding (by buttering/floating method) due to the required duty (live loads, outdoor exposure etc.).

Thanks to their special formulation and smooth-flowing properties, Sopro VF XL 413 VarioFlex® and Sopro VF 419 VarioFlex® Silver large-format flexible tile adhesives simplify the floor laying process and the achievement of more or less full bedding.

Earthenware



Stoneware



The open-pored rear face of earthenware and stoneware tiles ensures good interlock with the hydraulically setting adhesive.

Standard

Normal contract



Sopro FF 450

Fast-track contract



Sopro FF 451



Sopro's No.1
for walls and floors



Sopro VF XL 413
for floors only



Sopro VF 419
for floors only



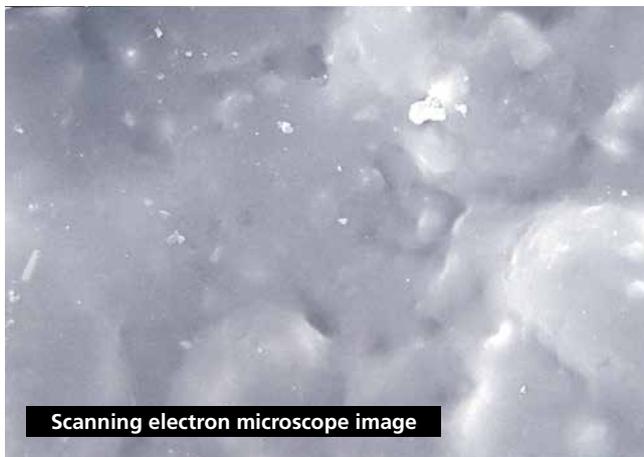
Ceramic tiles

Product recommendations

Alongside earthenware and normal stoneware, a third group of tile products made from fully vitrified stoneware is also very widely used. Despite the advantages of high density and low water absorption offered by these tiles, these same properties also have the drawback of weakening adhesion between the cementitious adhesive and rear tile face. As the microscope image shows, fully vitrified stoneware exhibits

a far smoother, denser surface than either earthenware or normal stoneware, thereby allowing little mechanical interlock between tile and hydraulically setting adhesive. Fully vitrified stoneware products therefore require the use of polymer-modified tile adhesives (with Class S1 or S2 rating to DIN 12 004) with high adhesive strength to ensure reliable bonding performance.

Fully vitrified stoneware



Scanning electron microscope image

The smooth, closed-pore tile face offers inadequate interlock for hydraulically setting adhesives. The use of polymer-modified (flexible) tile adhesives is therefore required to achieve a strong bond.

Recommendation



Sopro's No.1
Highly modified flexible adhesive, for walls and floors



Sopro FKM XL 444
Multi-purpose, extra-light, extra-high-coverage, low-dust flexible tile adhesive



Sopro VF XL 413
Floating-bed adhesive, for floors

Terracotta



A special fixing system is needed for laying hand-made tiles due to their typically high dimensional tolerances and open-pored texture.

Terracotta laying system



Sopro MB 414
Flexible medium-bed adhesive



Sopro MFb
Tile grout



Sopro ZSE 718
Cement skin remover for indoor use

* Meets C2 TE requirements to DIN EN 12004 where 10 mm serration is used.

Bonded tiles

As a further group of finishes, cast stone coverings particularly excel by their large formats and wide variety of designs.

Resin- and cement-bonded tiles



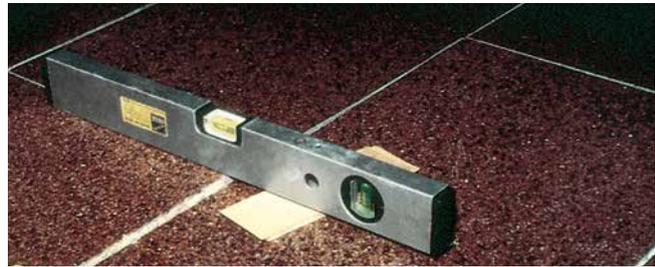
Resin-bonded tiles excel by their widely ranging designs and aesthetic appeal.

These typically take the form of attractively designed covering materials that demand particular care in the selection of a suitable adhesive.

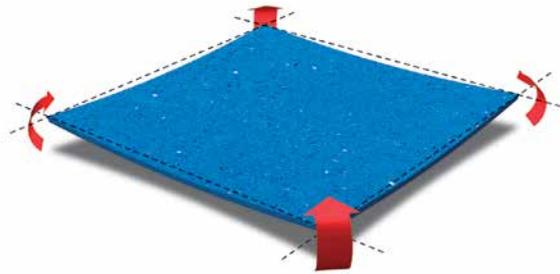
As these covering materials incorporate synthetic resin or cementitious binders, they may be prone to expansion/swelling upon exposure to moisture migration – brought about by the installation process – from normally setting hydraulic mortars, with non-uniform deformation ("dishing" or "curling" of covering) as the upshot. **This problem can be avoided through specification of a rapid-set, hydraulically setting adhesive** that ensures extra-rapid chemical/crystalline binding of the mixing water (e.g. **Sopro VF HF 420 or Sopro FKM 600**).

Yet, given the unsuitability of even rapid-set cementitious adhesives for a small proportion of the resin bonded tiles available on the market (due to their extremely high deformation sensitivity), the performance of a deformation test is generally recommended prior to flooring installation. In isolated cases (depending on the test results), use of a reaction resin material (e.g. Sopro PUK 503 PU adhesive) may offer the sole solution. Water-free reaction resin adhesives pose no threat to the shape and appearance of the covering material during installation. Sopro Bauchemie GmbH will perform in-house deformation tests for you prior to providing a project-specific recommendation.

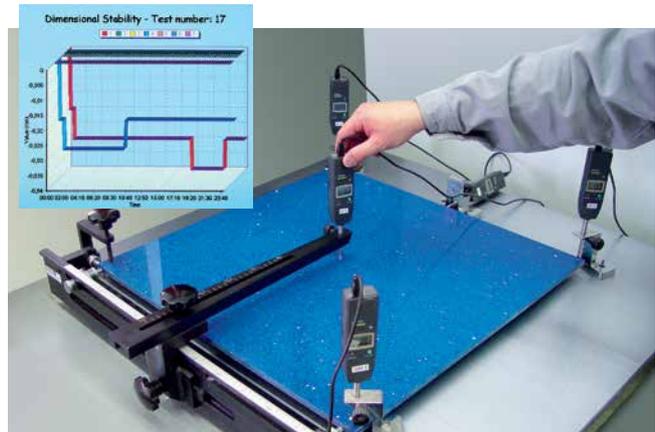
Product recommendations



Projecting tile corners ("steps") are not just unsightly, they also constitute a trip hazard and a cause for claims.



Dishing or curling of resin- or cement-bonded tile caused by water absorption on lower face during installation.



Deformation test on tile specimen using state-of-the-art technology.

Recommendation



Sopro VF HF 420
Extra-rapid-set floating-bed adhesive



Sopro FKM 600
Rapid-set, multi-purpose flexible tile adhesive with high crystalline water binding capacity



Sopro PUK 503
Polyurethane reaction resin adhesive

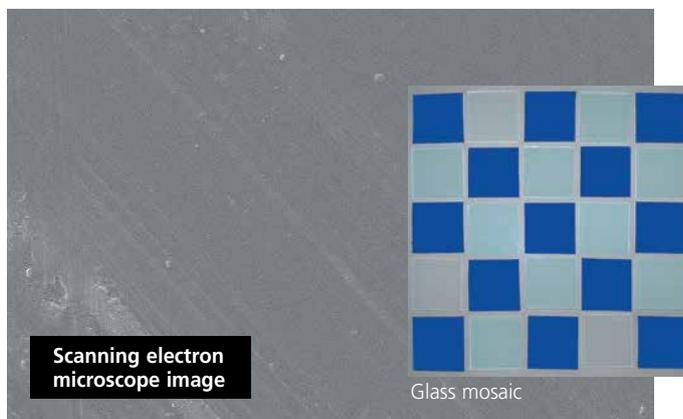
Glass and stone tiles

Product recommendations

Large-format glass tiles also feature among contemporary covering materials. Like fully vitrified stoneware, glass possesses an extremely smooth, dense surface, which allows practically zero water absorption (see scanning electron microscope image). Standard cementitious systems are unsuitable for laying this type of tile, and only reaction resin products (e.g. Sopro PUK 503 PU adhesive) are able to ensure a sufficiently strong bond between substrate and covering. Due to their permanent elasticity, these adhesives are able to prevent the transmission of stresses from the substrate to the brittle glass tiles.



Glass tiles



Water absorption prevented by smooth, non-porous surface. The ideal solution for laying glass coverings is a white reaction resin adhesive that guarantees a strong bond between substrate and rear face of glass tile without impairing the visual appeal (translucence) of the finish.



Sopro PUK 503
Polyurethane reaction resin adhesive, for walls and floors



Large-format glass panels can be reliably installed with Sopro PUK 503 PU adhesive.

Natural stone tiles



Special adhesive systems are required for natural stone. These feature rapid-set, trass-bearing and generally white cement-based products to ensure reliable, durable and discoloration-free tile laying.



Sopro MFK 446
White, rapid-set, flexible thin-bed tile adhesive, for walls and floors



Sopro MDM 885 white/grey
Flexible medium-/thick-bed adhesive, for walls and floors



Sopro FKM 600
Rapid-set, multi-purpose flexible tile adhesive with high crystalline water binding capacity

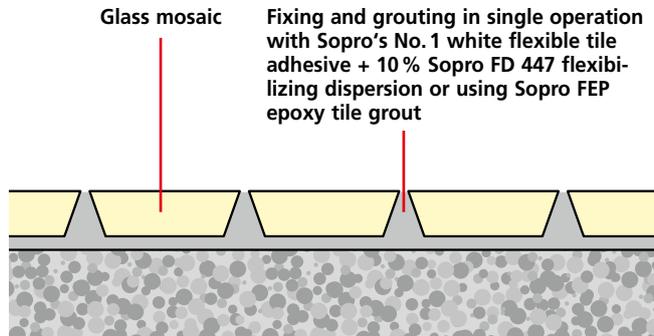
For detailed information, see Section 6
"Reliable laying of natural stone"



Mosaic

Mosaic products are made from ceramics, natural stone or glass. The individual units are held in place by an adhesive-fixed backing mesh or by paper or plastic sheeting stuck over the front face*. The high proportion and narrowness of joints in mosaic finishes complicates installation and, in particular, the grouting process. For this reason, preference should be given to tile-fixing systems that double up as grouts in order to prevent any impairment to the uniform colouring of the joint pattern through the escape of different-coloured adhesive at the joints.

Product recommendations



Ceramic, natural stone or glass mosaic



Mosaic is used for a wide variety of applications (bathrooms, swimming pools etc.). Due to the high proportion and narrowness of the joints and small adhesive bed thickness, these finishes are best installed using adhesive systems that double up as grouts and thereby speed up the working process.



Sopro's No.1 white
Allows fixing and grouting in single step

+



10% Sopro FD 447
for glass mosaic coverings

or



Sopro FEP plus
Allows fixing and grouting in single step



Glass mosaic held together by paper facing, here underwater application.

Specification of grout depending on loads and required colour



Sopro FEP and FEP plus
Allows fixing and grouting in single step



Sopro DF 10
Flexible designer tile grout



Sopro TF+
High-strength tile grout

***Note:** Only mosaic held in place at front (e.g. by sheet) should be used for underwater applications (swimming pools). Mosaic with backing mesh should be avoided due to risk of detachment! Note: Regular water treatment should be ensured where glass mosaic is installed in swimming pools due to the high proportion of joints. This will protect the joints from algal growth and possible fungal attack. See Section 4 "Tiling in swimming pool construction"/"Mosaic installation".

Vibrated floors

The use of vibrated floor techniques – whereby tiles are pressed by a surface vibrator into a mortar bed – for large-scale flooring installation in heavy-duty areas (warehouses, grocery stores etc.) now dates back several decades.

Dry-pressed ceramic tiles with low water absorption, including clinker floor tiles and fully vitrified stoneware, are among the most suitable covering materials.

Tiles with edge lengths of up to 25 cm have proved a reliable solution. The tiles should be at least 10 mm thick or specified to accommodate the projected loads – see ZDB (Federation of the German Construction Industry) data sheet "Heavy-duty coverings – ceramic floor coverings subject to high mechanical loads", October 2005). Design and installation are governed by the AKQR guidelines "Installation of vibrated ceramic floors" (July 2005).



Sopro RS 648 vibration slurry applied to prepared mortar bed.



Ceramic covering laid in freshly applied Sopro RS 648.

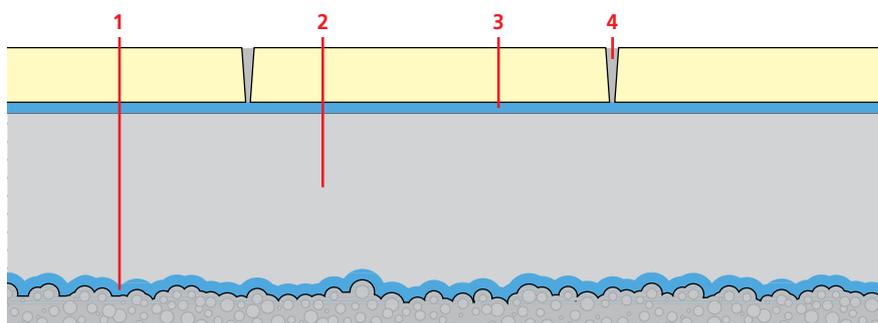
Mortar bed:

- 1** For bonded constructions: **min. 40 mm – compressive strength min. C16.**
- 2** For unbonded constructions: **min. 60 mm – compressive/flexural tensile strength min. C16/F3** or meeting requirements of structural calculation
- 3** For floating constructions: **min. 75 mm – compressive/flexural tensile strength min. C24/F4** or meeting requirements of structural calculation

The tiles are generally laid with narrow (1–2 mm), broken joints (staggered by 1/3 or 1/2). Some vibrated floor and clinker tiles are specially provided with spacer nibs that ensure a uniform joint pattern and prevent displacement of the covering during vibration.

Note: Where an unbonded or floating construction is adopted for the vibrated floor, particular care should be taken to ensure that the bedding mortar (screed) is fully pre-compacted. To reduce drying shrinkage and the stresses caused by this in the overall construction, the binder (cement) content should be minimized. Moreover, the screed mortar should be prepared with a very low water/cement (W/C) ratio. This can be achieved through the use of suitable superplasticizing admixtures.

For floating screeds (i.e. screeds laid on an insulation layer), any higher live loads should be accommodated by increasing the screed thickness rather than only the binder content, as the latter may intensify the shrinkage stresses. Despite the lower compressive and flexural tensile strengths, the greater screed thickness will enhance the stability (live load capacity) of the screed. At the same time, the stresses in the overall construction will be kept to a minimum.



- 1** Adhesion promoter – Sopro RS 648 vibration slurry
- 2** Mortar bed
- 3** Adhesion promoter – Sopro RS 648 vibration slurry
- 4** Sopro FEP 604 three-component epoxy tile grout

Vibrated floors

Construction and procedure:

- 1 Substrate or concrete slab is (blast-)cleaned to optimize adhesion of bonded vibrated floor construction.
- 2 Adhesion promoter (e.g. Sopro HSF 748 flexible bonding slurry with trass) is applied to concrete slab and (hydraulically setting) bedding mortar placed wet on wet to minimum thickness of 40 mm. Mortar – where necessary, with set retarded through use of Sopro EVZ 634 screed retarder – is struck off to required levels and pre-compacted.
- 3 Bonding layer (Sopro RS 648 vibration slurry) is applied to bedding mortar and ceramic tiles are immediately placed with tightly butted joints.
- 4 After installation of a vibratable area (15–20 m², depending on situation/ambient conditions and resultant setting behaviour of bedding mortar), surface vibrator is passed over covering and tiles vibrated into mortar bed.
- 5 Depending on duty required by later occupancy, finishing of joints with epoxy tile grout of adjustable consistency (Sopro FEP three-component) is recommended.
- 6 Vibrated floors are walkable after seven days and – in the case of normally setting systems – fully loadable after 28 days.



Surface vibrator for passing over ceramic coverings.



Surface vibrator passing over freshly laid ceramic covering.

Product recommendation



Sopro RS 648



Sopro FEP 604



1



2



3



4

Grouting (pictures 1–4)

The consistency of Sopro FEP three-component epoxy tile grout can be adjusted through the addition of crystal quartz sand in varying proportions. This ensures reliable sealing of even the narrowest joints (1–2 mm).

Vibrated floors Large-format ceramic units

For some time now, the design preferences of clients have been shifting away from the typical vibrated floor solutions described above. This is because the visual appeal of traditional, small-format, vibratable tile finishes is no longer deemed to meet contemporary standards. Instead, clients are seeking large-format units that are equally amenable to vibration as the small-format tiles. So far, the sizes most in demand range between around 30x60 cm and 40x40 cm.

Sopro has conducted its own in-house investigations into the use of larger formats for vibrated floors. Positive feedback has since been received from sites and projects where large-format units have been installed.

A decisive factor for the success of these large-format applications is the exceptional bond strength of the adhesion promoter (Sopro RS 648 vibration slurry). This ensures the achievement of full-surface, heavy-duty adhesion at the latest during the vibration process.

Of equal importance for the contractor is the high stability offered by the vibration slurry: this prevents displacement of the units when these walked over and when the vibrator passes over the covering.



Surface roller vibrator passing over 30 x 60 cm units laid in Sopro RS 648 vibration slurry.

The vibration slurry is prepared by mixing with water and combed onto the pre-laid mortar bed. To prevent premature setting of the bedding mortar (prior to vibration), its setting time can be delayed through the addition of Sopro EVZ 634 screed retarder.



Powder application technique is invariably problematic and is not advisable for large-format coverings.



Vibration slurry is mechanically mixed with water.



Vibration slurry spread over freshly laid mortar bed.



Large-format units laid in freshly applied vibration slurry.

Large-format ceramic units

An immense selection of large-format covering materials is now available on the market, with wide variations in size and, particularly, thickness. The largest units are now over 5 m² in area, with thicknesses ranging between 3.5 and 6 mm. They are suitable for wall and floor installation. Designers and applicators are presented with a wide variety of tile products from which they can choose the most suitable solution for their projects. A technical guidance paper entitled "Reliable laying of large-format coverings" is obtainable from the ZDB (Federation of the German Construction Industry). Sopro Bauchemie GmbH has responded to these new trends by offering special product systems and solutions for large-format coverings.

What are the implications of large-format coverings for clients, designers and applicators? Are they merely an additional source of risk or do they offer a real opportunity for successful specialists? Given due attention to a number of important points, the latter is true! Yet the entire project team must be open to new ideas. A rethink is needed in terms of design, pricing and site operations. This is crucial to the success of all contracts involving the installation of large-format coverings.

Relevant information is provided at the "large-format workshops" held under the Sopro Craft Academy programme.



Counselling:

The designers and applicators shall draw the client's attention to both the options and limitations in respect of large-format coverings. This counselling shall cover the issues of live loads and the desired visual impact. Half- or third-bond arrangements, for example, are not recommended for tiles subject to a certain degree of dimensional inaccuracy due to the unsightly shading effects produced by glancing light.

Such arguments can be compellingly reinforced by a practical demonstration with tiles laid out and exposed to glancing light.



Large-format floor tiles laid in entrance lobby.

Site set-up:

The proper installation of large-format units depends on the availability of suitable tools and equipment on site.

This ranges from a large table for accurate measurement and cutting of the units to lifting gear (suction cups) and a wide array of cutting tools for efficient handling and processing.



Cutting/working of large-format unit.



Suitable equipment is required on site to allow proper preparation of large-format units prior to laying.

Large-format ceramic units

Substrate assessment and residual moisture measurement for screeds

As part of the substrate assessment process, the moisture content of screeds to receive tiling shall be measured in advance using a CM tester.

Thresholds for cement screeds:	2–2.5 % unheated*
(to DIN 18 157)	2–2.5 % heated
Thresholds for calcium sulphate screeds:	0.5 % unheated
	0.3 % heated



Determination of residual moisture in screeds using CM tester.

Also crucial for successful installation and durable performance is the surface strength.

Other key factors include the bay sizes and movement joint layout.

Installation

The installation of large-format coverings invariably necessitates preliminary surface filling and levelling works to the substrate. This is because the substrate tolerances specified in DIN 18202 are too large to allow thin-bed laying of such units (thick-bed laying must be excluded as an option here!). Floor surfaces shall be evened out with the self-levelling filler Sopro FS 15 550 and wall surfaces with a sag-resistant, rapid-set filler (Sopro RAM3 454, see also Section 11).

* DIN 18517 specifies a tolerance range for the CM tester measurement results. For large-format coverings, a conservative approach is appropriate, with lower values targeted.



Application of Sopro FS 15 550 to create a level surface.

The large-format units shall be laid using the buttering/ floating method to ensure full and proper bedding. The adhesive crests on tile and substrate shall be kept parallel to each other as tests have shown this to deliver best results.



Application of adhesive to substrate and rear tile face.

During installation, particular care is required in the measurement, setting-out and working of the units in order to minimize offcut.



Bonding of large-format unit to wall with Sopro MG 679 MG-Flex® XXL rapid-set highly flexible tile adhesive.

Large-format ceramic units

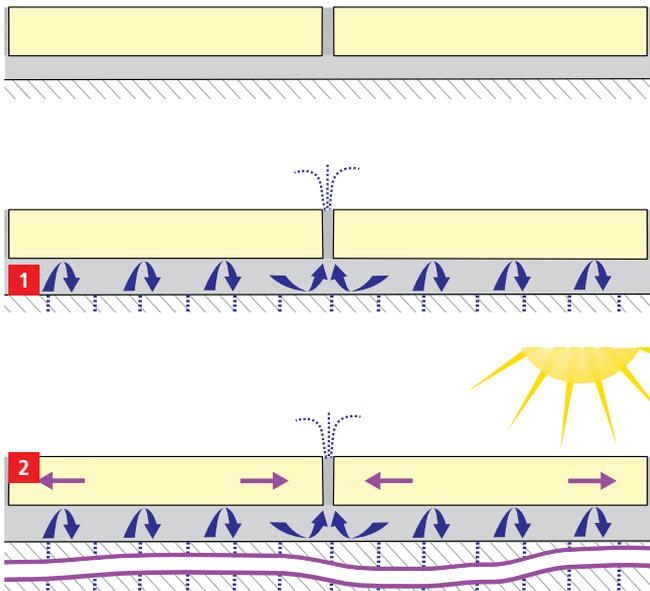
Calcium sulphate screeds

There is no fundamental reason why large-format units should not be installed on calcium sulphate screeds.

However, specification of a suitable primer and bedding adhesive is required in function of tile size.

Experience has shown that large-format coverings are particularly vulnerable to adhesion failure. This is, in part, due to the migration of surplus water from the specified thin-bed adhesive into the surface of the calcium sulphate screed (upward migration being prevented by the watertight barrier of the tiles), thereby reducing the strength of the screed.

Cause of adhesion failure on calcium sulphate screeds



- 1** Weakening of surface through migration of moisture from adhesive into screed surface.
- 2** Fracture in weakened zone.



Adhesion failure on calcium sulphate screed due to entrapped moisture.

Although calcium sulphate screeds that no longer require scuff sanding are now available on the market, the need for this preliminary treatment must always be assessed for the specific project.



Sanding of calcium sulphate screed as important preparation for durable bonding of tile covering.

Large-format ceramic units

Specification of tile-fixing products in function of tile size:

1 Tiles with edge length ≤ 60 cm and area ≤ 0.2 m² *



Primer

Sopro's No.1

Sopro VF XL 413

"Normal-setting adhesive"

2 Tiles with edge length ≤ 100 cm and area ≤ 1 m² *



Primer-sealer

Sopro's No.1

Sopro VF XL 413

"Normal-setting adhesive"

3 Tiles with edge length ≤ 100 cm and area < 1 m² *



Primer

Sopro VF HF
420

Sopro FKM 600

Sopro VF 419

"Rapid-set adhesive with high
crystalline water binding capacity"

4 Tiles with edge length > 100 cm and area > 1 m²



Primer

Sopro MEG 665

Sopro MG 679

* As special construction for 30x60cm tile sizes under DIN 18157, tile size shall be limited to ≤ 0.16 m². Please seek advice from Sopro Project Consulting team.



Application of easily workable Sopro MGR 637 multi-purpose primer to protect calcium sulphate screed against moisture migration.

Large-format ceramic units

S2-grade adhesives for laying large-format coverings

The fact that joints account for an ever smaller proportion of tiled surfaces reduces their importance and increases the need for high-performance bedding and bonding.

The internal stresses that accumulate within individual tiles must be reconciled with the existing substrate. Alongside their primary tile-fixing function, adhesives thus assume the additional task of accommodating the shear stresses that may occur.

The S2-grade products Sopro MG 669/MG 679 and Sopro MEG 665/MEG 666 are high-performance adhesives that are capable of meeting these demands and offering a high degree of security.

The specification of S2-grade adhesives is recommended for tile formats exceeding 1 m². Exceptions are only permissible in isolated cases, subject to prior consultation with Sopro's Technical Service team.



Laying of large-format ceramic units (indoors)

	Procedure	Use	Product recommendation
Priming	<p>To ensure trouble-free laying of large-format units, it is essential to check the substrate for adequate strength and levelness. The application of suitable primers and adhesion promoters is necessary to improve the strength and modify the suction of the substrate.</p> <p>Thin covering materials: The manufacturer of the covering material shall be consulted on its suitability for use in conjunction with a specific substrate and application/load case.</p> <p>Note: Coverings laid in high-moisture areas necessitate the incorporation of waterproof membrane systems from the Sopro range.</p> <p>Calcium sulphate screeds (moisture-sensitive)**: – Tiles with edge length ≤ 60 cm and area ≤ 0.2 m²: Sopro GD 749 – Tiles with edge length ≤ 100 cm and area ≤ 1 m²: Sopro GD 749 in conjunction with Sopro FKM 600, Sopro VF HF 420 or Sopro VF 419. – Tiles with edge length > 100 cm and area > 1 m²: Sopro MGR 637/Sopro EPG 522 in conjunction with Sopro S2-grade tile adhesive</p>	<p>Absorbent substrates (e.g. cement screeds, calcium sulphate screeds*, concrete, cement, lime/cement render, gypsum plasterboard)</p>	<ul style="list-style-type: none"> • Sopro GD 749 • Sopro SG 602 
		<p>Non-absorbent substrates (e.g. existing tile coverings, terrazzo, adhesive residue)</p>	<ul style="list-style-type: none"> • Sopro HPS 673 
		<p>Critical substrates (e.g. low-strength substrates, moisture-sensitive substrates)</p>	<ul style="list-style-type: none"> • Sopro MGR 637 or • Sopro EPG 522, in either case blinded with • Sopro QS 511 
Filling/levelling	<p>For the installation of large-format tiling, the substrate is required to exhibit a particularly high degree of levelness exceeding the requirements of DIN 18202 ("Tolerances in building construction"). A sufficiently even substrate for the subsequent laying of large-format tiles is ensured by the use of a suitable Sopro surface filler.</p> <p>In case of special substrates, e.g. mastic asphalt, please contact our Technical Service team.</p>	<p>Floor surfaces</p>	<ul style="list-style-type: none"> • Sopro FS 15 550 
		<p>Wall surfaces</p>	<ul style="list-style-type: none"> • Sopro RAM 3 454 • Sopro AMT 468 
Laying	<p>Practically void-free, full bedding is essential for guaranteeing a failure-free finish. This means that, in addition to the adhesive bed applied to the substrate, the rear face of the covering materials also receives an adhesive coat (buttering/floating method).</p> <p>Particularly where thin covering materials are laid on floors, the adhesive shall be applied generously to the corners of the tiles so as to ensure full bedding at the joint intersections. Inadequate bedding may result in cracking or a hollow ring to the tile finish.</p> <p>Rapid-set tile adhesives shall be used where inadequate drying time is available prior to walking over and grouting of covering. Particular attention shall be given to the format restrictions specified by the manufacturer when installing thin covering materials on floors.</p>	<p>Floor surfaces (all substrates) up to 1 m² tile area</p>	<ul style="list-style-type: none"> • Sopro VF HF 420*** • Sopro VF 419*** • Sopro VF XL 413 
		<p>over 1 m² tile area</p>	<ul style="list-style-type: none"> • Sopro MEG 665 • Sopro MEG 666 • Sopro MG 669 • Sopro MG 679 
		<p>Wall and floor surfaces (all substrates) up to 1 m² tile area</p>	<ul style="list-style-type: none"> • Sopro FKM XL 444 • Sopro FKM 600*** • Sopro's No.1 • Sopro's No.1 Silver 
		<p>over 1 m² tile area</p>	<ul style="list-style-type: none"> • Sopro MG 679 • Sopro MG 669 • Sopro MEG 667 
Grouting	<p>Cementitious joints in tile coverings act as a sort of buffer for accommodating incident stresses. Due to the large tile formats, joints now account for a relatively small proportion of the tiled surface. Joint widths of at least 3 mm have proved reliable in practice. The overall area shall be subdivided by movement joints into suitably sized bays. For further assistance, please contact our Technical Service team.</p> <p>Note: Narrow joints (1–2 mm) shall be finished with Sopro DF 10 or Sopro FEP plus.</p>	<p>Tile grout</p>	<ul style="list-style-type: none"> • Sopro DF 10 • Sopro FEP plus 
		<p>Silicone</p>	<ul style="list-style-type: none"> • Sopro Sanitary Silicone 

* Up to a tile size of 1 m² where Sopro VF HF 420/Sopro MEG 666/Sopro FKM 600/Sopro VF 419 tile adhesive is used.

** Please seek advice from Sopro's Project Consulting team.

*** For calcium sulphate screeds.

Installation of tiles on facades

External wall claddings

Ceramic claddings represent an ever-popular facade solution among clients and designers on new-build projects.

The benefits are obvious: the different formats and immense variety of colours cater for a wide range of design options. The resulting surfaces offer high mechanical resistance, do not weather or soil very quickly, and are easy to clean with water and a scrubber.

In Germany, the design and application of such solutions is governed by DIN 18515 "Cladding for external walls – Tiles fixed with mortar". Given that facades are extremely sensitive building elements that need to permanently withstand all types of weather condition, proper design and construction are crucial. Failure to comply with good practice invariably leads to failures in the form of cracks or fractures, which are all the more critical due to the location of the tiles on the external wall surface.

Meticulous design and strict compliance with DIN requirements are paramount. Project-specific checks and analyses are essential wherever deviations are unavoidable.



Facade with ceramic tile finish.

Ceramic coverings manufactured and tested to standard

DIN EN 14411

"Ceramic tiles – Definitions, classification, characteristics and marking"

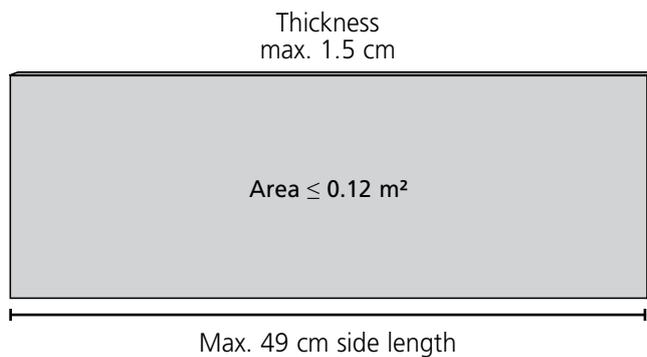
and with certified frost resistance are suitable for facades.



Installation of tiles on facades

Requirements of DIN 18515 for ceramic claddings

Maximum tile dimensions:



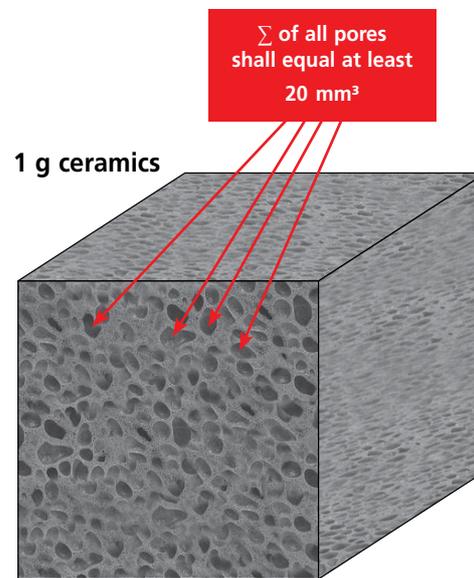
Of crucial importance for the durable bonding of ceramic tiles using hydraulically setting adhesives is the pore volume of the tile body, i.e. the ceramic product must to a certain degree exhibit an open-pored texture. As a rule of thumb, the minimum pore volume within one gram of the ceramic product shall be 20 mm^3 .

Moreover, to ensure strong interlock with the hydraulically setting adhesive, the rear face (bonded surface) of the tile shall have open pores with a minimum size of $0.2 \text{ }\mu\text{m}$ ($2 \times 10^{-4} \text{ mm}$).

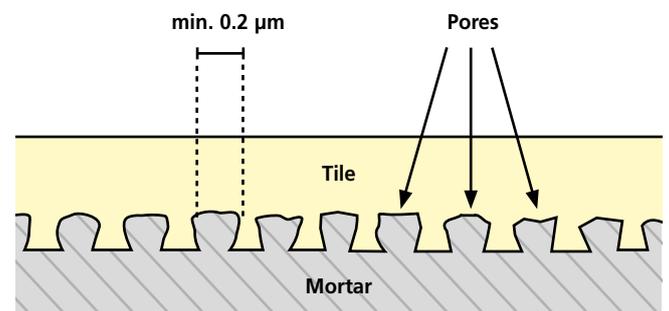
The rear face of a ceramic tile is required to exhibit pores of a minimum size. This is decisive for ensuring a strong interlock with the cementitious adhesive.

Note:

With ribbed/fluted tiles, the total tile thickness incl. ribs/fluting may run to 2 cm.



1 g ceramics shall contain a minimum pore volume of 20 mm^3 .



Note:

Ceramic tiles that fail to meet these requirements cannot be installed on facades using standard, hydraulically setting adhesives! Here, S2-grade or reaction resin adhesives may offer a suitable solution.

Other suitable facade cladding materials include natural stone units to DIN 18516 Part 3, provided these have certified frost resistance, and cast stone units to DIN 18500. Glass mosaic, though not covered by the DIN standards, has also delivered good results in practice.

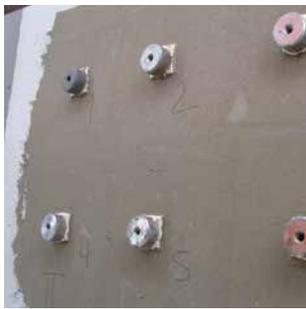
Installation of tiles on facades

Requirements:

- Strong substrate required: tensile adhesion strengths $\geq 0.5 \text{ N/mm}^2$
- Substrate shall be free from adhesion-impairing substances
- Irregularities shall be levelled out
- Renders shall be at least 10 mm thick
- Reinforcement needed for render thicknesses exceeding 25 mm
- Render shall meet mortar group P III requirements to DIN 18550
- Render with reinforcement and anchor ties is required for composite or insufficiently strong substrates

Test for substrate strength

A minimum value of 0.5 N/mm^2 is required.



Tensile adhesion test



Sopro FKM XL 444

A DIN EN 12004-compliant adhesive shall be used for thin-bed laying. Installation shall comply with DIN 18157. A minimum adhesive bed thickness of 3 mm shall be observed.

Tiles shall be laid using buttering/floating method, i.e. rear face of tile shall also be coated with adhesive.



Application to substrate ("floating").

+



Application to rear tile face ("buttering").

Tensile adhesion test on installed ceramic cladding

A minimum value of 0.5 N/mm^2 is required.



Tensile adhesion test on installed ceramic cladding.

Installation of tiles on facades

Grouting

The required joint widths depend on the type of covering:

- Ceramic tiles 3–8 mm
- Ceramic split tiles 4–10 mm
- Split brick tiles and clay cladding materials 10–12 mm
- Natural stone units 4–6 mm
- Cast stone units 3–12 mm

The joints shall be slurry-grouted using a hydraulically setting tile grout.



Slurry application of hydraulically setting flexible tile grout.



Sopro DF 10



Sopro FL plus

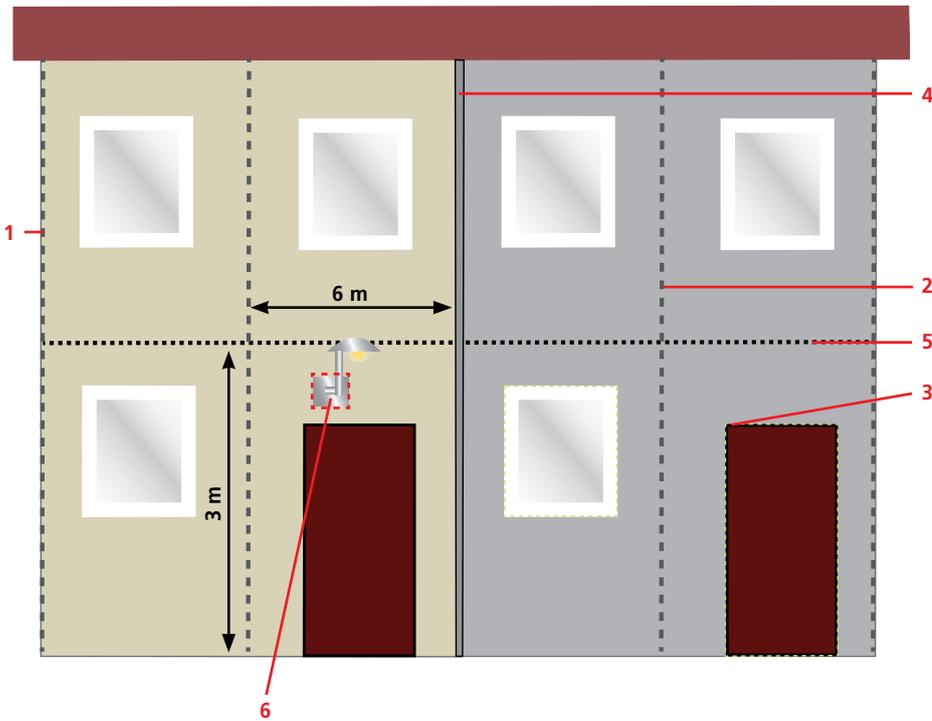


Washing down of slurry-grouted surface.

Installation of tiles on facades

Subdivision of facade areas with movement joints

Due to weather exposure and high temperature fluctuations, facade areas require subdivision by movement joints into bays.



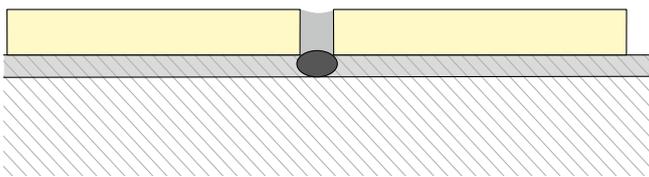
System composition

- 1 Movement joints at edges and corners
- 2 Bay perimeter joints
- 3 Joints at junctions with other elements
- 4 Structural joint
- 5 Horizontal joint (bay perimeter joint at floor slab)
- 6 Joints with services installations

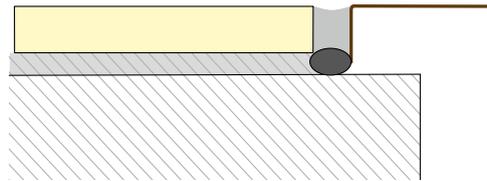
Note:

The guide value for movement joint spacing is 3 m for horizontal and 6 m for vertical joints.

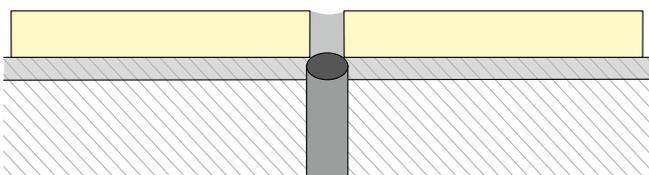
Joint details:



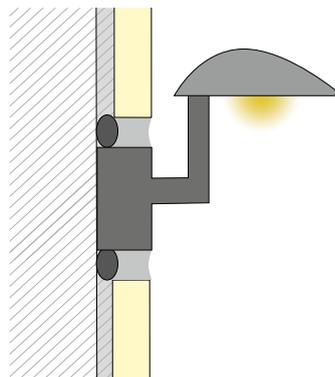
- 1 Movement joint at edges and corners and Bay perimeter joint
- 2 Bay perimeter joint and Horizontal joint
- 5 Horizontal joint



- 3 Joint at junctions with other elements (e.g. door or window frame)



- 4 Structural joint

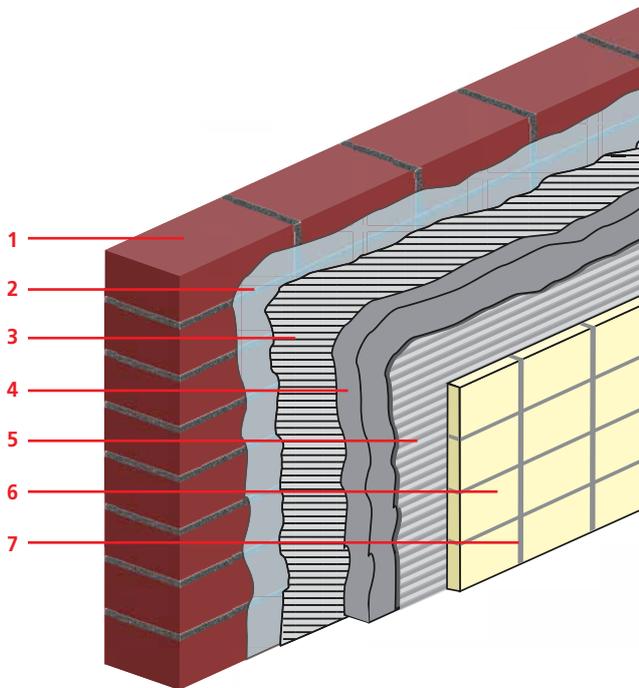


- 6 Fixture, fitting, services installation

Installation of tiles on facades

Solution 1 to DIN 18515

■ Ceramics installed directly on masonry/concrete



System composition

- 1 Masonry
- 2 Sopro GD 749 primer



- 3 Skim coat Sopro's No.1 flexible tile adhesive



- 4 Render undercoat Sopro AMT 468 levelling mortar with trass or Sopro RAM 3 454 renovation and levelling mortar



- 5 Bedding adhesive Sopro MEG 667 megaFlex TX highly flexible tile adhesive



- 6 Tile

- 7 Grouting Sopro FL plus flexible tile grout or Sopro DF 10 flexible designer tile grout



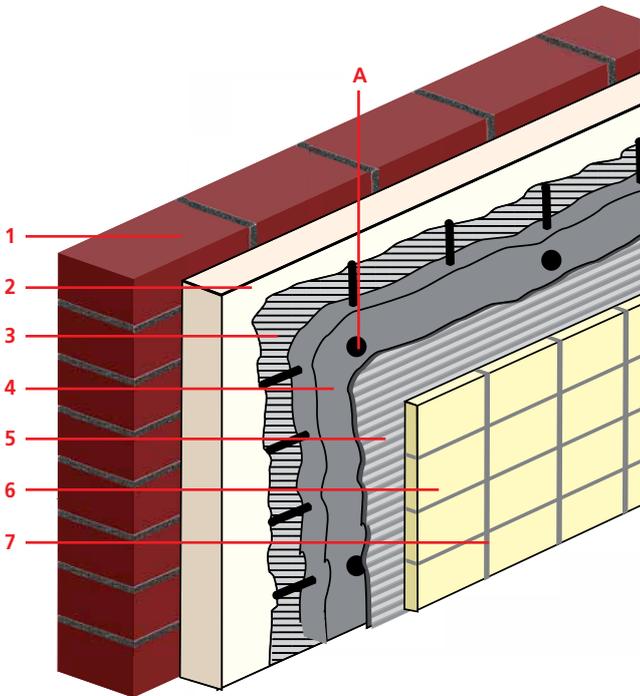
Installation of tiles on facades

System 2, not covered by DIN 18515 (requiring project-specific check)

Ceramics installed on thermal insulation

Given the need for greater energy efficiency, clients are encouraged to insulate their buildings properly. This has major implications for facade design. If tile claddings are nonetheless required, this is possible under DIN 18515.

Here, the insulation layer is overcoated with a structurally self-supporting render that later serves as the substrate for installing the ceramic finish.



System composition

- 1 Masonry
- 2 Thermal insulation
- 3 Skim coat
Sopro's No.1 flexible tile adhesive



- 4 Reinforced render undercoat Sopro RAM 3 454 renovation and levelling mortar



- 5 Thin-bed adhesive Sopro MEG 667 megaFlex TX highly flexible tile adhesive



- 6 Tile

- 7 Grouting Sopro FL plus flexible tile grout or Sopro DF 10 flexible designer tile grout



- A Anchor tie

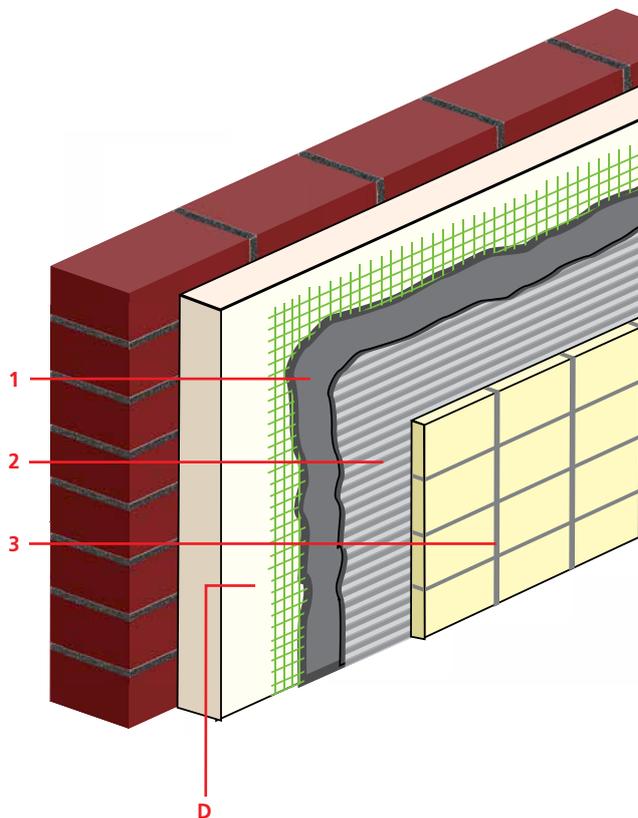


Installation of tiles on facades

System 3, not covered by DIN 18515 (requiring project-specific check)

■ Ceramics installed on external thermal insulation composite system

- Thermal insulation shall be adhesive bonded and additionally anchored.
- In case of expanded polystyrene and rock wool insulation, anchors shall be carried through reinforcement layer.
- Insulation shall be adequate for load transmission.
- **The wide variety of possible combinations necessitates a project-specific check.**



System composition

- 1 Surface filler coat using Sopro's No.1 flexible tile adhesive with Sopro AR 562 scrim reinforcement



- 2 Bedding adhesive Sopro MEG 667 megaFlex TX highly flexible tile adhesive



- 3 Grouting Sopro FL plus flexible tile grout or Sopro DF 10 flexible designer tile grout



- D Insulation
ETICS (external thermal insulation composite system)

Installation of tiles on facades

System 4, not covered by DIN 18515 (requiring project-specific check)

Tile installation on suspended base panels using thin-bed method

- Base panels are fixed to supporting structure on facade. Here, type of structural fabric is irrelevant.
- Back-ventilated system is possible.
- Manufacturer shall ensure adequate load transmission.
- **The wide variety of possible combinations necessitates a project-specific check.**



Facade assembly featuring glass mosaic laid on base panel.

System composition

- 1 Base panels
- 2 Surface filler coat using Sopro's No.1 flexible tile adhesive with Sopro AR 562 scrim reinforcement



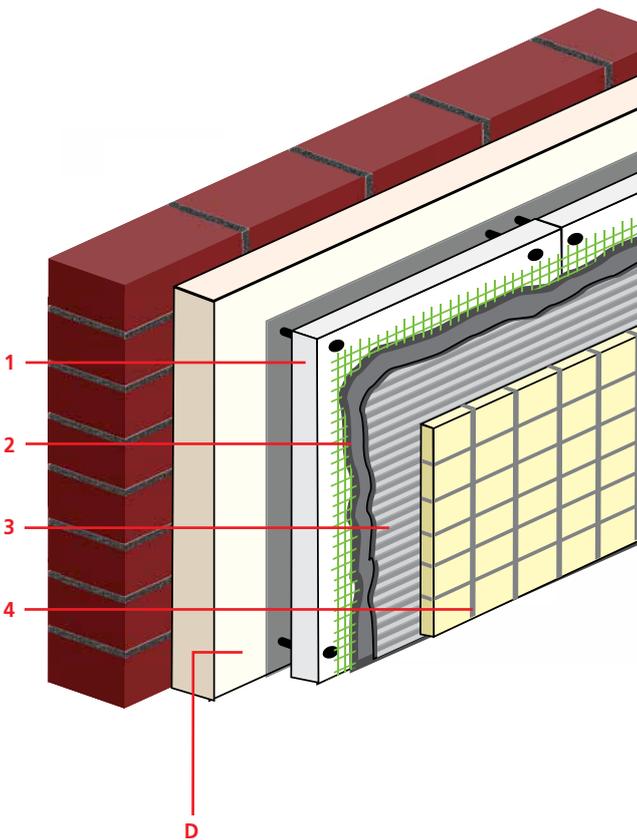
- 3 Bedding adhesive Sopro MEG 667 megaFlex TX highly flexible tile adhesive



- 4 Grouting Sopro FL plus flexible tile grout or Sopro DF 10 flexible designer tile grout



D Insulation



Installation of tiles on facades

External wall claddings

A further cladding option, alongside "tiles fixed with mortar" dealt with in DIN 18 515, involves the use of facing (natural stone) masonry units fixed in mortar on supports. Up to now, this type of cladding was covered by DIN 18 515 Part 2. In the wake of revisions to the standard, this part has now been withdrawn. It can still, however, serve as the basis for design and construction.



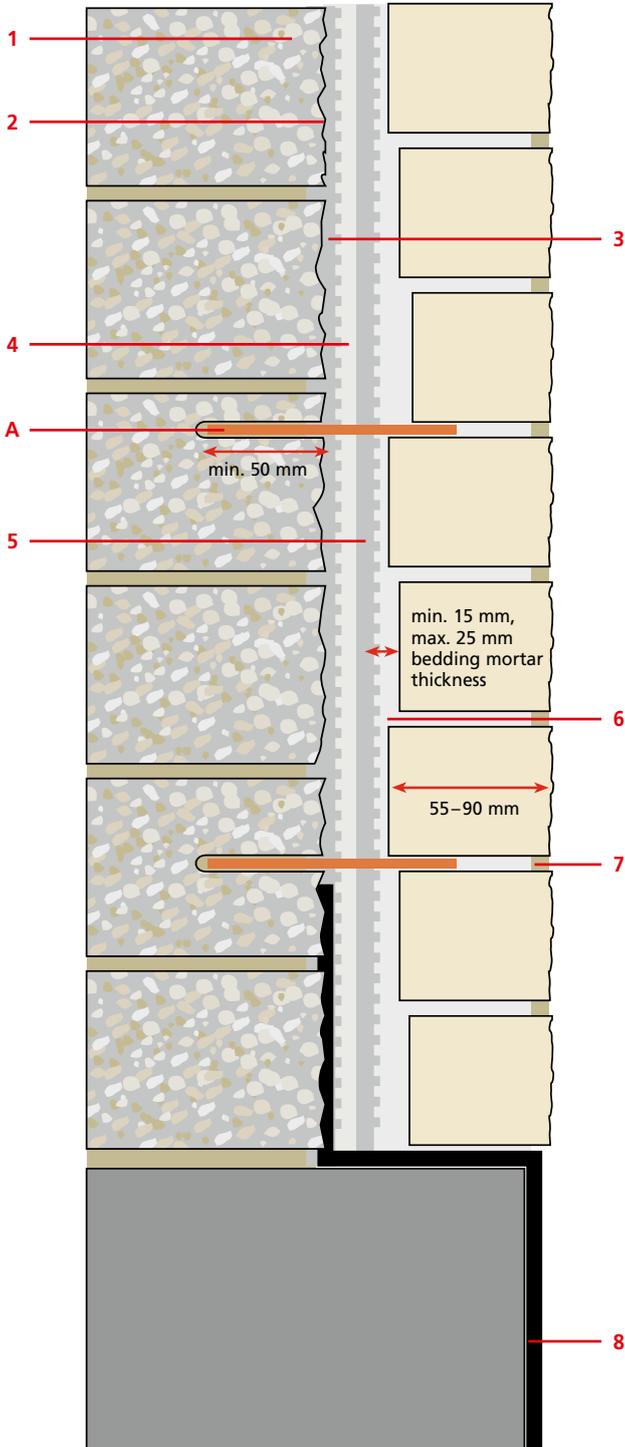
Facing masonry units fixed on supports.

Particularly crucial for this type of assembly is a suitably dimensioned support structure to serve as a base for the min. 55-90 mm thick masonry units. The masonry units are bonded to the structural wall and additionally anchored back with stainless steel wire ties. This type of external cladding system is permissible for residential buildings with two main storeys plus 4 m gable roof and for other building categories up to a height of 8 m.

DIN-Normen im Wortlaut		8
DK 692.232.4 : 691.421.4 : 699.833		April 1993
Außenwandbekleidungen Anmauerung auf Aufstandsflächen Grundsätze für Planung und Ausführung		DIN 18 515 Teil 2
Cladding for external walls, facing bricks fixed in mortar on supports; Principles for design and application Revêtements de parois extérieures; pierres de revêtement fixées par mortier sur appuis; principes de calcul et exécution		Mit DIN 18 515 T 1/04/93 und DIN 18 515 T 1/01/90 Ersatz für DIN 18 515/07/70 und Beiblatt zu DIN 18 515 12/73
Inhalt		
		Seite
1 Anwendungsbereich		1
2 Zweck		1
3 Begriffe		1
4 Baustoffe für die Anmauerung		2
5 Anforderungen		2
6 Verankerungen		2
7 Ausführung		2
8 Bewegungs- und Trennfugen		3
Zitierte Normen		3
1 Anwendungsbereich Diese Norm gilt für Außenwandbekleidungen von Bauwerken und Bauteilen, die auf Aufstandsflächen an der Rohbauwand angemauert und verankert werden. Die Höhe der Außenwandbekleidung darf bei Wohngebäuden zwei Vollgeschosse zuzüglich einem Giebeldach von 4 m Höhe oder bei anderen Gebäuden eine Höhe von 8 m nicht überschreiten. Die Dicke der Anmauerung beträgt ≥ 55 mm bis < 90 mm, für Dicken ≥ 90 mm gelten DIN 1053 Teil 1 und Teil 2.	3.2 Aufstandsfläche Aufstandsflächen sind konstruktive Bauteile, die die Eigenlast der Außenwandbekleidung aufnehmen. ANMERKUNG: Diese können z. B. Fundamentvorsprünge, thermisch getrennte Deckenstreifen, nichtrostende oder korrosionsschutzte Stahlkonsolen nach DIN 55 928 Teil 2, Teil 5 und Teil 6 sein.	
2 Zweck Die Außenwandbekleidung erbringt den Regenschutz, schützt gegen andere Einwirkungen aus der Atmosphäre, sowie gegen mechanische Beanspruchungen und dient der Gestaltung.	3.3 Verankerung für die Anmauerung Verankerungen für die Anmauerung sind Verbindungen zwischen der Außenwandbekleidung mit der Rohbauwand aus nichtrostenden Drahtankern, die eingemauert, eingedübelt oder nachträglich eingemörtelt werden. Es sind nur zugelassene bzw. genehmigte Verankerungen (nach Abschnitt 6) zu verwenden.	
3 Begriffe 3.1 Außenwandbekleidung auf Aufstandsflächen Außenwandbekleidungen auf Aufstandsflächen mit Anmauerung sind die äußeren Bekleidungen von Bauwerken und Bauteilen.	3.4 Spritzbewurf für die Anmauerung Der Spritzbewurf für die Anmauerung ist ein einlagiger dünner Mörtel. ANMERKUNG: Der Spritzbewurf dient zur Verbesserung der Haftung des Unterputzes.	
		Fortsetzung Seite 2 und 3
Normenausschuß Bauwesen (NABau) im DIN Deutsches Institut für Normung e.V.		
VOB-Mat.-Sammlung Lief. 37/1993		Teil 8

Installation systems

Facing masonry assembly



For max. 8 m wall heights

- 1 Structural wall
- 2 Sopro GD 749 primer
- 3 Sopro's No.1 flexible tile adhesive, combed on as bonding layer for levelling render
- 4 Sopro AMT 468 levelling mortar with trass or Sopro RAM 3 454 renovation and levelling mortar to even out gross irregularities
- 5 Sopro's No.1 flexible tile adhesive, combed on as bonding layer for bedding mortar
- 6 Sopro MDM 888 medium-/thick-bed tile adhesive, Sopro MB 414 medium-bed flexible tile adhesive or Sopro FKM 600 Silver multi-purpose flexible tile adhesive
- 7 Joints finished with Sopro MFs and Sopro MFb tile grout
- 8 Waterproofing with Sopro ZR 618 cementitious reactive waterproof membrane
- A Wire tie (min. 5 stainless-steel wire ties with min. 3 mm diameter required per m²)



Note:

Bedding adhesive thickness may be reduced where masonry units are of uniform thickness and substrates are level.

Installation systems

Facing masonry installation



Concrete facing masonry units.



Supporting surface on concrete basement floor slab.



Concrete facing units fixed to concrete substrate with Sopro FKM 600 Silver multi-purpose flexible tile adhesive using buttering/floating method.



Drilling of holes for mechanical anchorage of facing with ties.



Inserted anchor tie for mechanical fixing.

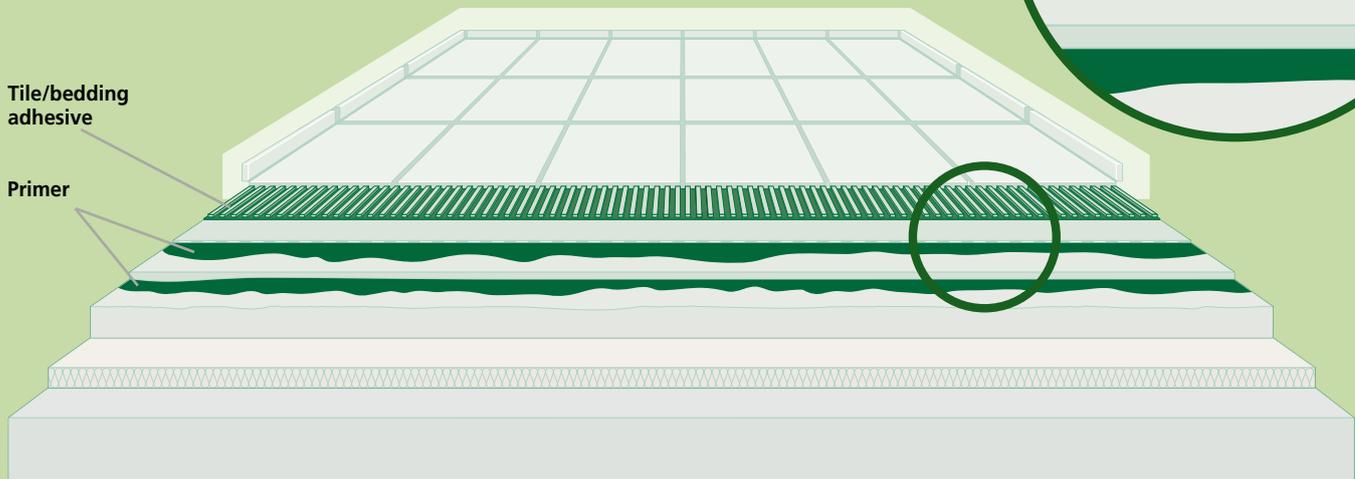


Further example of anchor tie.



Anchors shall be accurately positioned, with an adequate number provided per square metre.

Sopro product systems for sustainable construction



Schematic system composition

Low-emission primers*



Sopro GD 749
DGNB:
 Top quality level 4,
 Line 8**



Sopro HPS 673
DGNB:
 Top quality level 4,
 Line 8**



Sopro MGR 637
DGNB:
 Top quality level 4,
 Line 8**



Sopro SG 602
DGNB:
 Top quality level 4,
 Line 8**

Low-emission tile / bedding adhesives*



Sopro's No.1
DGNB:
 Top quality level 4,
 Line 8**



Sopro's No.1
 white rapid-set
DGNB:
 Top quality level 4,
 Line 8**



Sopro FKM XL 444
DGNB:
 Top quality level 4,
 Line 8**



Sopro FKM 600
DGNB:
 Top quality level 4,
 Line 8**



Sopro MDM 885
DGNB:
 Top quality level 4,
 Line 8**



Sopro MDM 888
DGNB:
 Top quality level 4,
 Line 8**

* For details of all relevant Sopro products, please consult our sustainability brochure.

** Rating under German Sustainable Building Council (DGNB) quality certification scheme, Criterion "ENV1.2 Local Environmental Impact" (2018 version).